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MISSISSIPPI-IOWA-CEDAR RIVERS BASIN: A COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

Public Health Service
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A COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM

for the

Mississippi-Iowa-Cedar Rivers Basin

Developed by the State Water Pollution Control Agencies
of
ILLINOIS, IOWA, and MINNESOTA

1954

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FOREWORD

Our country's development over the past 50 years has been marked by tremendous progress in many fields. It has made possible great gains in the health, comfort, and well-being of the people. But it has not been without cost. Part of the cost has been the damage to the Nation's water resources that has resulted from wastes discharged to the streams by our growing cities and industries. All water uses have been affected--public water supplies, recreation, agriculture, industry, fish and aquatic life.

In enacting the Federal Water Pollution Control Act in 1948, the Congress declared that "water pollution has become a matter of grave concern in many areas and its damaging effects on the public health and national resources are a matter of definite Federal concern as a menace to national welfare. Abatement must be undertaken in order to control it."

The Public Health Service, as part of its responsibilities under this Act, is required to prepare or adopt, in cooperation with other Federal agencies, State and interstate water pollution control agencies, and municipalities and industries, comprehensive programs for the abatement of pollution.

This report contains the comprehensive water pollution control program for the Mississippi-Iowa-Cedar Rivers Basin of the Iowa State Department of Health, Illinois Sanitary Water Board, and the Minnesota State Department of Health. The program is sound and gives full consideration to the several present uses and to the reasonably anticipated future uses of the waters of this basin. It provides an equitable balance in the pollution control requirements for various private and public groups concerned.

I am pleased, therefore, in my capacity as Surgeon General of the Public Health Service, to adopt the program developed by the State water pollution control agencies of Iowa, Illinois, and Minnesota for the Mississippi-Iowa-Cedar Rivers Basin as a comprehensive program which fully meets the requirements of the Federal Water Pollution Control Act.

This program is based on beneficial water uses and related conditions that prevailed on July 1, 1953. Comprehensive programs for pollution control must necessarily be flexible. They must allow for growth, development, and changing conditions. Any significant changes affecting water quality, such as stream flow, (water use, industrial development, population, etc., may require) changes in the pollution control program.

Obviously the mere adoption of this program will not, in itself, reduce pollution or improve the usefulness of the waters in this basin. It does provide to the citizens of the area and to the city officials and industrial leaders, farmers, fishermen, conservationists, and others an objective plan based on good engineering practice, and reflecting sound economics. It is a plan which the public can support, and must support, if progress is to be made in the abatement of pollution.

Certain additional considerations beyond the mere acceptance of a plan are essential to its successful execution. The citizens of the areas affected must see that sufficient resources are provided to the State water pollution control agencies concerned to enable them to make the technical investigations to aid those responsible for constructing pollution abatement works.

We must recognize, too, that in order to be fully effective the plans and programs of one State must be geared closely to those of adjoining States, since State boundaries are no barrier to pollution traveling in interstate streams. Above all, no program of this nature can progress beyond the report stage if its meaning and purpose are not made clear and understandable to the citizens of the area. In the final analysis they are the ones who will pay, directly or indirectly, for the pollution abatement works that are needed.

It is my hope that this program for the Mississippi-Iowa-Cedar Rivers Basin will be carried through to completion so that the area may enjoy all the benefits that clean water can provide, in health and recreational opportunities for the people and in sound growth of industry and agriculture.

Leonard A. Scheele

Leonard A. Scheele
Surgeon General

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

This report, prepared in cooperation with the water pollution control agencies of Iowa, Illinois, and Minnesota, sets forth the water pollution control program being followed by the respective States in the Mississippi-Iowa-Cedar Rivers Basin. This program, which is based on data available as of July 1, 1953, was developed after a thorough consideration of the existing and potential uses of the water resources in the basin; the pollution entering the streams and the resulting damages; the benefits which may result from pollution prevention and abatement; and the prevention measures now in effect as well as those which are needed.

Agencies which cooperated in the preparation of this report included the Iowa State Department of Health, Illinois Sanitary Water Board, and Minnesota State Department of Health. Likewise, acknowledgment is made to the Corps of Engineers, Department of the Army; Soil Conservation Service, Department of Agriculture; Bureau of Census, Department of Commerce; Bureau of Mines, Fish and Wildlife Service, and Geological Survey, Department of Interior; and the Federal Power Commission for their review of the report and for the information obtained from their published reports. Acknowledgment is also made of information obtained from the report of the Committee on Water Resources, Iowa State Planning Board.

COMPREHENSIVE WATER POLLUTION CONTROL PROGRAM
for the
MISSISSIPPI-IOWA-CEDAR RIVERS BASIN

General Characteristics and Economic Development

The Mississippi-Iowa-Cedar Rivers Basin lies for the most part in east-central Iowa with small portions in southeastern Minnesota and northwestern Illinois. It comprises 13,380 square miles of the Mississippi River watershed and is drained by the Iowa, Cedar, and Edwards Rivers which discharge to the Mississippi River downstream from Davenport, Iowa, and near New Boston, Illinois.

Many of the streams have cut through the glacial drift prevalent in this region to underlying rock and the main streams flow sluggishly in meandering courses. Little or no flow regulations exist in the basin since there are only a few natural lakes and those are in headwater regions. Extreme low flows are experienced during the late summer and early fall periods as well as during the midwinter period.

Climate of the basin, although slightly influenced by the Gulf of Mexico, is predominantly continental. Monthly mean temperatures vary from lows of 10° F. in the north and 33° F. in the south to highs of 71° F. and 76° F. Over half of the annual 28 to 34 inches rainfall occurs during the growing season. At points in the upper portion of the basin, the average annual snowfall is 46 inches. Thunderstorms are common and result in sudden freshets. Prolonged droughts have been experienced.

The basin lies in one of the Nation's most productive agricultural regions which is noted mostly for corn, swine, and cattle. Development of agriculture has been accompanied by a thriving industrial development consisting primarily of the manufacture of farm machinery and the processing of farm products.

At present, almost three quarters of a million people inhabit the basin. Five communities have populations greater than 20,000. Although a large percentage of the population is concentrated in a small percentage of the towns, most of the people live in communities of less than 5,000. The average per family income in the basin was $4,376 in 1950, about the same as the Nation's average.

Water Use and Water Quality Objectives

Waters of the basin serve a variety of uses, such as municipal, industrial, and stockwater supplies, propagation of fish and wildlife, recreation, hydroelectric power production, and navigation. Over half the basin's population is served by community water supplies. Twenty-one percent of these obtain water from the four communities which use surface water sources. Some communities, now using well water, may find it necessary, because of increasing demand on the underground reserves, to go to surface water sources in the future. The extent of development of private industrial water supplies is un-

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known but, judging from the wastes discharged and the nature of the industries (predominantly food processing), it must be substantial.

Surface waters of the basin are used extensively for watering livestock. Livestock raising, one of the basin's principal economic pursuits, depends in great measure on sufficient quantities of good quality water.

The basin's waters serve as a recreation facility for many people. Most of the streams are fished and some of the waters, particularly in the headwater's regions, serve as wildlife habitats. There are numerous recreational developments on both artificial and natural lakes. The Mississippi River supports some commercial fishing.

There are a few hydroelectric power developments which serve local users. Navigation is limited to the Mississippi River. Quite importantly, the watercourses serve as final outlets for the wastes of the basin's communities and industries.

Water quality objectives have been reasonably well established for most of the important water uses and are discussed in the body of this report under the section "Use of Water Resources." These criteria together with desirable general sanitation objectives, such as the removal of floating and settleable solids, elimination of nuisance conditions and the preservation of aesthetic values provide a basis for the determination of the necessary degree of treatment for protection of existing and foreseeable legitimate water uses.

Sources and Effect of Pollution

Nearly 343,000 people, about half the basin's population, in 92 communities have sewer service. Sewage with a population equivalent of 246,000 is discharged from 83 of these communities. The other 9 communities with a sewered population of nearly 30,000 are discharging an undetermined amount of sewage to the watercourses.

In addition to the municipal sewage discharged to the waters, a substantial amount of industrial waste, in addition to that tributary to municipal sewers, is discharged through private outfalls. The population equivalent of the wastes from 24 of the 37 industries reported to be discharging organic wastes to the waters of the basin is approximately 219,000. Thus, the known municipal and industrial pollution discharged to the watercourses of the basin is equivalent to the wastes from about 465,000 persons.

Thirty-six of the existing municipal sewage treatment plants are considered to have inadequate capacity and 22 are not being operated satisfactorily. Eight of the 23 industrial waste treatment plants are considered to have inadequate capacity while four are not operating satisfactorily.

The basin waters are polluted to varying degrees, with nuisance conditions occurring in a few localities. There are a number of points on the streams where water uses have been damaged by pollutional discharges from municipalities, canneries, dairy products plants, meat packing plants, etc. Sewage pollution from municipalities presents a public health hazard where the waters are used

for public water supply or recreation. For the most part pollution damages are localized, but, in a few instances where numerous sources of waste exist, pollution damage is spread over longer reaches of the streams.

Pollution is making it increasingly difficult to provide a safe and palatable water in some of the basin's communities, is damaging water quality for fish and wildlife maintenance, and has deteriorated recreational use of some streams.

Progress in Pollution Abatement

Pollution abatement is well advanced in this basin. Sewage treatment is provided by 83 communities for 93 percent of the basin's sewered population. These communities are operating 18 primary and 65 secondary sewage treatment plants. Only 10 communities do not provide treatment at present and these have a total combined population served by sewers of only 23,550 persons. Twenty-three of the 37 industries discharging wastes to the watercourses provide treatment.

The water pollution control laws of the States in this basin appear to be adequate to abate existing pollution and prevent or control new or increased sources of pollution. The State water pollution control programs have been quite successful, but in order for the State agencies to pursue a more effective and active program, they must be furnished with adequate appropriations to attract sufficient trained personnel to carry on and expand their activities.

At the present time, 15 municipalities are either actively planning new sewage treatment facilities or have plans approved for such work, and four municipalities have sewage treatment facilities under construction. Four industries have plans under preparation or approved for new treatment works, and one has a plant under construction.

Pollution Prevention Measures Required

Excellent work has been done on pollution control within recent years, but to adequately control or prevent pollution there are still a number of projects that must be built. Analysis of the available data which consider stream flow characteristics, the amount of wastes discharged to the watercourses, present water quality in the streams, and existing water uses in relation to generally accepted water quality objectives has made possible the determination of treatment requirements for the major sources of pollution in the basin. These requirements consist of 30 new plants (10 for systems without treatment serving 23,550, and 20 for systems with unsatisfactory treatment plants serving 27,630) and enlargements or additions to 15 existing plants serving 188,850.

It is estimated that the construction of these facilities will cost approximately $7,500,000. The cost estimate does not include such items as sewers, interceptors, land, right-of-way, etc., which will vary with every project and with local conditions. Neither do these figures include operation and maintenance costs.

Ten new industrial waste treatment facilities, two enlargements, and three replacements are required in order to adequately reduce the industrial pollution load now being discharged to streams in this basin. Many of these needed plants will be small. No close estimate of cost of industrial waste treatment plants is possible since the nature of the wastes and possible process improvements vary widely, even within identical industrial groups.

Additional data will be required to completely determine the total pollutional load from all municipalities and industries. However, the data now available will allow the continuation of a comprehensive program for the elimination of many of the pollutional problems that now exist.

Water Pollution Control Program

The needed corrective measures discussed herein and listed below are based upon studies, and observations by the responsible water pollution control agencies in the States concerned, which in some cases did not include a field investigation of pollutional conditions in the receiving stream. In these cases recommendations are made on the premises of providing treatment where such facilities do not now exist and for expansions and improvements to existing facilities where they are now not entirely adequate to protect the stream under all conditions. Thus the mere fact that they are included in the listing does not always indicate the existence of a pollutional condition in the stream which is seriously damaging to water use. Nevertheless they are deemed advisable for restoring, preserving, and protecting the stream for all legitimate water uses including those that now exist and those which may materialize in the foreseeable future.

The corrective measures listed below are flexible and are intended to reflect the needs for the situation as it now exists; however, changes in stream characteristics, pollutional load, or water uses may require revisions in the future in the treatment requirements.

1. Provide the following improvements:

Name and Location	Improvement Needed	Remarks
Ackley, Iowa	Replacement of existing treatment plant	
Adams, Minnesota	New treatment plant	
Albert Lea, Minnesota	Replacement of existing treatment plant	Plans approved for joint treatment plant.
Wilson & Co.	New treatment plant	
Alden, Minnesota		
Alden Creamery	New treatment plant	
Austin, Minnesota	Enlargement of existing treatment plant	Active planning
Belmond, Iowa	Replacement of existing treatment plant	Active planning
General Mills Soybean Plant	New treatment plant	

Name and Location	Improvement Needed	Remarks
Blairstown, Iowa	Replacement of existing treatment plant	
Blooming Prairie, Minnesota	Additions to existing treatment plant	Plant B
Britt, Iowa		
Britt Rendering Plant	New treatment plant	
Cedar Rapids, Iowa	Enlargement of existing treatment plant	Active planning
Quaker Oats	Connect to Municipal sewer	Active planning
Penick & Ford	Connect to municipal sewer	Active planning
Center Point, Iowa		
Center Point Cannery	New treatment plant	
Charles City, Iowa	Additions to existing treatment plant	
Clarksville, Iowa	Replacement of existing treatment plant	
Clear Lake, Iowa	Enlargement of existing treatment plant	Contract awarded
Columbus Junction, Iowa	New treatment plant	
Conrad, Iowa	Replacement of existing treatment plant	
Denver, Iowa	Replacement of existing treatment plant	
Dows, Iowa	Replacement of existing treatment plant	
Dumont, Iowa	Enlargement of existing treatment plant	
Forest City, Iowa	Additions to existing treatment plant	
Garwin, Iowa	Replacement of Existing treatment plant	
Gilman, Iowa		
Gilman Cannery	Enlargement of irrigation facilities	
Gladbrook, Iowa	New treatment plant	Final plans approved
Greene, Iowa	Additions to existing treatment plants	Both East and West plants
Grundy Center, Iowa	Replacement of existing treatment plant	Under construction
Cannery	Replacement of existing treatment plant	Plans approved
Hampton, Iowa	Enlargement of existing treatment plant	
Hudson, Iowa	Replacement of existing treatment plant	Active planning; joint plant
Hudson Creamery	New treatment plant	
Lake Mills, Iowa		
Cool Springs Cannery	New treatment plant	

Name and Location	Improvement Needed	Remarks
Lyle, Minnesota	New treatment plant	
Marengo, Iowa	New treatment plant	Final plans approved
Mason City, Iowa	Enlargement of existing treatment plant	
Rendering Plant	New treatment plant	
Morning Sun, Iowa		
Rendering Plant	Replacement of existing treatment plant	
Muscatine, Iowa	New treatment plant	Active planning
Nora Springs, Iowa	New treatment plant	
Northwood, Iowa	Replacement of Existing treatment plant	
Creamery	New treatment plant	
Osage, Iowa	Additions to existing treatment plant	Plans approved
Rendering plant	New treatment plant	
Reinbeck, Iowa	Replacement of existing treatment plant	Under construction
Riverside, Iowa	New treatment plant	
Sheffield, Iowa	Replacement of existing treatment plant	Final plans approved.
Shellrock, Iowa	New treatment plant	
Stacyville, Iowa	Additions to existing treatment plant	
St. Ansgar, Iowa	Enlargement of existing plant	
Toledo, Iowa	Replacement of existing treatment plant	Active planning
Toledo Canning Co.	Enlargement of existing irrigation facilities	
Union, Iowa	Replacement of existing treatment plant	
Walcott, Iowa	Replacement of existing treatment plant	
Wapello, Iowa	New Treatment Plant	
Waterloo, Iowa	Enlargement of existing treatment plant	Active planning
Rendering Plant	Connect to municipal sewer	
John Deere Co.	Replacement of existing treatment plant	Active planning
Waverly, Iowa	Additions to existing treatment plant	Under construction
Carnation Milk Co.	Connect to municipal sewer	Under construction
Waverly Canning Factory	Connect to municipal sewer	
Wellman, Iowa		
Turkey Plant	New treatment plant	
West Branch, Iowa	Replacement of existing treatment plant	Final plans approved

Name and Location	Improvement Needed	Remarks
Williamsburg, Iowa	Replacement of existing treatment plant	Under construction
Wilton, Iowa	Replacement of existing treatment plant	Active planning

2. Operation of all existing and future municipal and industrial waste treatment works be brought to a uniformly efficient and high level in order to obtain maximum benefits from these facilities and permit their most effective utilization.

3. Continue general policy of requiring adequate treatment of sewage and industrial waste from both new pollution sources and expanded use of existing facilities in order to preclude new pollution problems.

PHYSICAL DESCRIPTION

The Mississippi-Iowa-Cedar Rivers Basin comprises 13,380 square miles of the Mississippi River watershed and is drained by the Iowa and Cedar Rivers in Iowa and Minnesota, the Edwards River in Illinois, and the direct drainage of the included reach of the Mississippi River. The major portion of the basin, 88 percent, lies in east central Iowa, with 7 percent in southeastern Minnesota and 5 percent in northwestern Illinois.

The Iowa River falls 730 feet in a 365-mile southeasterly course from its West Branch origin, Crystal Lake, in Hancock County, Iowa, to its confluence with the Mississippi River. The Cedar River flows southeasterly some 300 miles from its source near Hayfield, Dodge Country, Minnesota, approximately 40 miles upstream from the Minnesota-Iowa State line, until it joins the Iowa River 18 miles southwest of Muscatine, Iowa, near Columbus Junction, and 29 miles upstream from the Mississippi River. The Edwards River falls 182 feet in its 77-mile westerly course from its South Edwards River origin near Galva, Henry County, Illinois, to its confluence with the Mississippi River near New Boston, Illinois.

The Iowa and Cedar Rivers flow, for the most part, through typical glacial country. Channels in many cases have been cut through glacial drift and the deeply buried original soils to underlying rock. Generally the basin is composed of gently rolling hills. Outcrops of sandstone, limestone, and shale are found along some of the river banks. There are lakes and marshes in the upper reaches of some of the streams. Because of a lack of general distribution of lakes throughout the basin there is little flow regulation and consequently wide variations in stream flow. The main streams flow sluggishly in meandering courses, particularly in their lower reaches where the valleys are subject to flooding from either excessive runoff or backwater from the Mississippi River.

Distribution of the annual rainfall, which ranges from 28 inches in the northern part of the basin to 34 inches in the southern portion, is such that 60 percent occurs during the spring and summer months. In the upper watershed snowfalls amount to 46 inches annually. Prolonged droughts have been experienced which resulted in substantial reduction in stream flow. Violent thunderstorms are common and give rise to sudden freshets causing localized flood damage. The basin lies in that portion of the Midwest which derives great benefit from the moisture-laden warm air from the Gulf; however, the climate of the basin is continental.

January, the coldest month, has average temperatures varying from 10° F. in the north to 33° F. in the south and the hottest month, July, has temperatures varying from 71° F. in the north to 76° F. in the south. Wide variations in monthly mean temperatures have been experienced. July temperatures have reached 110° F. and January temperatures have fallen to -20° F.

Major tributary streams to the Iowa River are East Branch, Bear Creek, and English River. Tributary to the Cedar River are Little Cedar River, Shellrock River, West Fork, Blackhawk Creek, and Prairie Creek.

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The power company dam at Cedar Rapids, Waterloo Dam, and Waverly Dam on Cedar River and power dams at Coralville and Iowa Falls on Iowa River, have a slight regulating effect on stream flows.

Drought, reservoir regulation for peak power generation, and ice have caused some very low flows in the main streams of the basin. As shown in the following table, minimum mean monthly flows occur during August, September, January, or February, and maximum daily flows occur usually in June.

Stream flow extremes at various sites in the Mississippi-Iowa-Cedar Rivers Basin

Site	Minimum mean monthly flows			Maximum daily flows		
	Flow in c.f.s.	Date	Years of Record	Flow in c.f.s.	Date	Years of Record
IOWA RIVER						
Rowan, Iowa.....	5.40	Feb. '50	1941-50	3,840	June '44	1941-50
Marshalltown, Ia. ..	13.7	Jan. '40	1938-50	48,000	June '18	1915-27 1933-50
Iowa City, Iowa.....	48.8	Feb. '40	1938-50	36,200	June '18	1903-50
Wapello, Iowa.....	497.	Feb. '40	1938-50	94,000	June '47	1915-50
CEDAR RIVER						
Mitchell, Iowa	44.8	Aug. '34	1933-40	13,000	Apr. '34	1933-40
Waterloo, Iowa*.....	401.	Dec. '49	1941-50	55,600	June '47	1941-50
Cedar Rapids, Iowa..	304.	Sept.'40	1938-50	72,000	Mar. '29	1903-50
Conesville, Iowa....	359.	Feb. '40	1939-50	60,000	June '41	1939-50
LIME CREEK						
Mason City, Iowa....	10.6	Jan. '40	1938-50	9,400	Mar. '33	1932-50
EDWARDS RIVER						
Orion, Illinois.....	4.5	Jan. '48	1941-50	4,560	Jan. '46	1941-50

*Higher flow at Waterloo than Cedar Rapids due to shorter period of record.

ECONOMIC DEVELOPMENT

It is believed that until the visits of Joliet and Marquette in 1673 and of LaSalle and Toni in 1682, the Mississippi-Iowa-Cedar Rivers Basin was unknown to white men. These explorers penetrated little of the basin beyond the immediate shores of the Mississippi River, and not until the beginning of steamboat service on the river in the 1830's did large numbers of settlers start moving into the area. At that time the land was mostly a great open prairie with fertile soils; therefore, it was natural that agriculture should, from the beginning, assume a position of commanding importance.

Railroad service was established by 1855, and increasing numbers of settlers began moving into the area. Growth of commercial centers in Missouri, Illinois, Minnesota, and Iowa resulted in an ever increasing demand for basic foodstuffs, such as wheat, corn, meat, and dairy products. The prairie land was well suited to produce these items in great quantity, and in doing so the basin became a leading producer of swine, cattle, and corn.

Closely following the extensive agricultural development came a natural growth of allied industry to furnish its needs and process its products. Among the most important of these industries are farm machinery manufacturing plants, and food processing plants such as creameries, canneries, meat packing plants, and rendering works.

By 1950 the basin's population had grown to 715,300. Ten communities had populations of 10,000 or more and accounted for more than 40 percent of the basin's total. Communities with populations of 20,000 or more were: Austin, Minn. (23,100); Iowa City, Iowa (27,212); Mason City, Iowa (27,980); Waterloo, Iowa (65,198); Cedar Rapids, Iowa (72,296). The basin-wide average population density is 53 persons per square mile (an increase of 9 percent over 1940); it varies by county from 24 in Mercer County, Ill., to 194 in Blackhawk County, Iowa.

The basin's income is derived predominantly from agriculture and associated industry. Approximately one-fifth of the income is represented by value added to products by manufacture. In 1950 the per family income, reported by country averages, varied from $2,980 to $5,159 and averaged $4,376, about the same as the national average.

USES OF WATER RESOURCES

Uses of the basin's water resources are numerous. Among the most important are: supplies for domestic and industrial needs and for livestock production; fishing; swimming; boating and other recreation; wildlife maintenance; navigation; and waste disposal. Use of the surface streams for livestock watering is by far the most widespread throughout the basin and fishing is the second most popular water use. However, domestic water supply is considered the primary water use in several locations.

There are 147 communities which have developed the water resources to serve the domestic and industrial needs of 362,000 people, about half the basin population. Surface water is the source of supply for three systems which serve 4 communities with a total population of over 77,000 or 21 percent of that population served by public water systems. Two of these supplies come from rivers which have numerous sources of pollution. They are Cedar Rapids and Iowa City (serving also Coralville). The water supply of the State University of Iowa at Iowa City is also a surface supply being obtained from the Iowa River. The City of Clear Lake obtains its water from Clear Lake.

Most of the water systems obtaining water from underground sources serve populations of less than 1,000 and appear to have adequate sources of supply although in certain cases the mineral content may be objectionable. There are, however, eight systems in communities of greater than 10,000 population which serve over 166,000 people. The water consumption by some of these eight systems, plus the large use by industries, has caused appreciable lowering of the local ground water tables in some areas, thereby increasigng the difficulty of obtaining an adequate supply. With continued increase in demand on these ground water supplies, the situation may become critical and require the development of surface sources.

Source water quality objectives are among the factors considered in determining treatment requirements for pollution sources upstream from municipal and domestic supplies. In determining suitability of source water for domestic supply, State health and water works officials use Public Health Bulletin 296, "Manual of recommended Water Sanitation Practice," as a guide.

The quantity of surface water used by industry for cooling or process purposes, with or without treatment, is not known but it seems reasonable to assume that, with the importance that industry has reached throughout much of the basin, the quantity of surface water required and used must be large. Because of the diversity of needs, quality requirements for industrial water supplies vary widely, depending upon the needs of the industry under consideration. No general criteria have been adopted and each case must be considered separately. Of general concern are the organic and biological constituents, toxic substances, and properties of corrosion, encrustation, and slime formation of the available waters.

The raising of livestock is an activity of great economic importance to this basin. The use of surface streams for livestock water supply is widely practiced and of paramount importance in the production of high quality livestock. Water quality objectives for stockwatering have not been precisely

defined, but the authorities agree that the elimination of such pollution as floating and settleable solids and high bacterial concentrations is desirable if the water is to be used for agricultural purposes.

The main streams and their tributaries are used for recreational purposes including fishing, boating, cabin sites, camping, and picnicking. Since most of the lakes are confined to the northern portion of the basin, heavy angling pressure is applied to the inland streams. Studies have shown that over half of the fishing in Iowa is done along the streams. Part of the popularity is due to the fact that most of the cities, and therefore the greatest population, are adjacent to the rivers which are used during weekends and holidays during a large part of the year.

Water quality objectives for fishing waters vary with the type of aquatic life to be protected. The general objectives advocated by the U. S. Fish and Wildlife Service, calling for a balanced aquatic life habitat and limiting concentration of pollutional substances, are usually used by authorities in this basin. Consequently, sludge beds, silt sedimentation, and other deposits which tend to blanket the stream bottom and destroy the biological life so vital to the existence of fish are highly undesirable.

Although boating and other recreation is enjoyed on the basin's streams, it is much more popular on the lake developments where winter sports are held in addition to the regular summer activities. Swimming in natural waters is limited almost entirely to the lakes. Sport fishing in the Mississippi River in the reach covered by this report is popular, and commercial fishing on the river is a substantial industry.

Contamination of bathing waters by sewage, especially that of recent origin, is objectionable, as water for recreational usage should be free from floating solids, sludge banks, odors, and discoloration. Quality objectives for the bacteriological quality of bathing waters recommended by the Joint Committee on Bathing Places (Joint study by the American Public Health Association and Conference of State Sanitary Engineers, covered in a report entitled "Recommended Practice for Design, Equipment, and Operation of Swimming Pools and Other Public Bathing Places," 1949), together with sanitary surveys, are employed in the administration of pollution control programs as related to bathing waters of this basin. Under the Joint Committee interpretation, various classifications of waters are defined as based on the number of coliform organisms per 100 milliliters of water. Other indices of quality, as enterococci, are receiving increasing attention; however, sanitary surveys are employed in pollution control programs as related to bathing waters. Although quality objectives for water used for nonswimming recreation do not set forth as high a bacteriological criterion, the same basic fundamentals are used by the States in their programs.

Some of the basin's waters, particularly in the headwaters regions, serve as habitats for wildlife. The Mississippi River serves as a body for navigation of considerable importance, and Muscatine, Iowa, is the basin's only river port.

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Due to the irregular flow and relatively low heads available on the majority of streams, power development is not considered an important water use at present. However, there are several hydro-electric power developments in the basin that produce power for local use.

All of these water uses are considered essential for the improvement of the economic conditions, health, and welfare of the people in the basin, and conservation of the water resources will be necessary for the continued development of the area. Treatment of the wastes discharged to the watercourses will be necessary to achieve the pertinent water quality objectives and thus maintain the streams in a suitable condition for the indicated water uses.

POLLUTION CONTRIBUTED TO THE WATER RESOURCES

As a consequence of man's activities throughout the basin, substantial amounts of pollution are discharged to the surface waters. Pollution of greatest concern is that from the urban areas where the burden on the water resources is greatest. Another type of pollution is that arising from extensive agricultural use of the land without sufficient soil conservation practice to prevent erosion and the resultant siltation of the watercourses. Although sewage discharged by small communities is not as important when compared case for case as that from the large population centers, it does present a problem because there are many such communities spread over the entire basin.

This basin, with over 200 communities of 100 population or more, has 92 communities which have sewer systems to carry away their domestic wastes. These systems serve a population of nearly 343,000, about half of the basin's total population.

Of the 92 sewered communities 83 are reported to be serving 313,105 people and discharging raw sewage or sewage treatment plant effluent with a population equivalent of about 246,250. Nine communities, serving a combined population of 29,710, discharge an undetermined amount of waste.

TABLE A.--Sewered municipalities*

Municipalities*	Number	Population served by sewerage system	Amount of Pollution discharged to watercourse (In terms of equivalent number of people)
Having data on pollution load discharged to watercourse....	83[1]	313,105	246,250
Having population data available (Data on pollution load to watercourse incomplete or not available).....	9	29,710	Not applicable
TOTAL.....	92	342,815	xxx xxx

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers; sanitary sewage wastes discharged by industry directly to watercourse, and industrial wastes discharged into municipal sewage systems.

[1] Includes one municipality which discharges through the sewer system of another.

In addition to the municipal sewage and industrial waste discharged to the waters through municipal sewers, a substantial amount of industrial waste is discharged directly to watercourses through private outfalls. The known population equivalent is approximately 218,550 for 24 of the 37 industries re-

ported as disposing of liquid wastes to the waters of the basin. Twenty-three of the 37 industries are treating their wastes.

TABLE B.--Separate industrial* outlets

Industries*	Number	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes.....	24	218,550
Producing organic wastes.....	12	Not known
Producing inorganic wastes.....	3**	Not applicable
TOTAL.....	37***	xxx xxx

*Includes all industries with outlets for the discharge of waste to the watercourse regardless of the status of treatment.
**Also includes two industries which also produce under organic wastes.
***Total adjusted to correct for duplication noted in footnote marked thus,**.

The sewer systems of the 10 communities with greater than 10,000 population serve over 256,000 people. These people represent more than one-third of the basin population and a little less than three-fourths of all the basin's sewer-connected population. Four of these 10 systems with a combined actual population of 151,000 collect sewage that, because of included industrial waste, has a population equivalent of about 980,000 which is over six times the population served. Sewage with a population equivalent of only 185,900 is discharged to the main streams of the watershed from these 4 communities. This represents a high degree of pollution reduction.

Austin, Minnesota, which collects sewage with a population equivalent of 80,000 (80 percent industrial waste), discharges an inadequately treated effluent with a population equivalent of over 25,000 to Cedar River. The present treatment plant has two stages of trickling filters, but is overloaded. Engineering studies have been made of the treatment plant and special studies are now under way at the packing plant which is the major source of industrial waste. Albert Lea, Minnesota, discharges an effluent with a population equivalent of 7,300 from a primary sewage treatment plant serving 11,000. A large packing plant adjacent to the city discharges wastes with a population equivalent of 38,000 through its own outfall. Plans have been completed for a joint treatment plant and negotiations are under way for financing the project.

The most critical stream pollution in Iowa results from wastes discharged at Mason City to Lime Creek, and at Waterloo, Cedar Falls, and Cedar Rapids to the Cedar River. In these communities industry is a large contributor to the strength of the municipal waste.

Waterloo, with a sewered population of 55,000, produces sewage, mostly industrial waste, with a population equivalent of 500,000. The effluent discharged from its sewage treatment plant has a population equivalent of 80,000.

Cedar Rapids, 70 miles downstream from Waterloo, with a population served of 60,000, has a raw sewage with an average population equivalent of 350,000. The sewage treatment plant discharges an effluent with a population equivalent of 80,000. There are also two food processing industries here that discharge, through their own outfalls, wastes with a population equivalent of 150,000.

The quantities of silt borne by the streams are evidence that soil conservation practices are, not carried out at present in sufficient magnitude to prevent erosion of substantial amounts of soil. This silt is a form of pollution which can impair many of the water uses, such as water supply for domestic and industrial purposes, stock-watering, fish and wildlife propagation, and swimming. This inorganic pollution is more in evidence during high waters as contrasted to the effects of organic pollution which are usually more noticeable during low flow conditions.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Pollution contributed to the water resources has resulted in damage in certain reaches of the basin's streams. This damage varies according to the degree of pollution added and the degree to which the water resources are used or might be used were the pollution decreased. Damage to or loss of usefulness of the water is a consequence of overloading the water resources beyond their capacity to assimilate pollutional materials. Such conditions in this basin have usually been due to one or more of the following: excessive bacterial pollution, high demand by organic material for the dissolved oxygen; presence of toxic chemicals; increased mineral content; and presence of color, odor or taste-producing substances.

Water supplies for Iowa City and Cedar Rapids are obtained from Iowa River and Cedar River, respectively. Both of these rivers receive sewage (treated) and surface wash upstream from the water intakes. In both cities the water purification plants are diligently operated for production of a safe water distributed to the consumers. Even though excessive pollution is not continuous in the river at the water intakes, it does move down from the upstream sources at times and temporarily involves the waters used for domestic purposes.

Users of the Mississippi River's waters downstream from the basin are subjected to some pollutional hazard by the discharges of sewage and industrial wastes at Muscatine, Iowa.

Perhaps the most widespread loss resulting from water pollution is that of the stock farmer. Stock producers must have a source of inexpensive, rather high quality water which will produce sufficient yield year-round. Throughout the basin there are reaches of streams polluted to the extent that stock-watering use is reported to be damaged. The damage involves loss of use of the water in the more grossly polluted reaches or potential hazard to the stock, in the form of toxic materials or disease organisms.

Sport fishing has suffered damage because of pollution. Numerous stream reaches are polluted to varying degrees, and this pollution, plus the frequently high silt loads, serves to make sport fish propagation difficult. The fact that most of the streams experience wide variations in flow conditions aggravates this problem. Pollution in some cases, while not eliminating the fish, causes a tainted flesh taste making fishing unattractive. This situation has been reported on the Mississippi River.

Damage has been reported to other water uses, such as wildlife maintenance, boating and other recreation, and industrial water supply. Possibly pollution or threats of pollution, as well as the wide fluctuations in stream flow, has resulted in the development of water recreation facilities on lakes instead of streams. Some of these lake developments are in headwater areas above sources of pollution, while some are on tributaries near communities which are damaging downstream water uses by their pollutional discharges. Some of the recreational developments might be located closer to the population centers if pollution were reduced or eliminated.

Most of the pollution damage in the basin is local in effect. There are a few cases, however, where pollution extends for considerable distances downstream. At times, pollution in Shellrock and Cedar Rivers moves from its sources in Minnesota down into Iowa causing damage to water uses. There are a number of cases where pollution causes damage to all water uses and in some of these the damage is so severe as to create nuisances. There are several small streams where pollution damages water uses along reaches of close proximity, e.g., Lime Creek, Blackhawk Creek, and the upper reaches of the Iowa River.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

The existing municipal sewage treatment plants of the basin have been of great value in preserving the water resources. Had it not been for these plants pollution would have increased much faster with the settlement and development of the basin, and water use would have been more seriously damaged than it is now. It is an accepted fact that man cannot live in this environment and maintain it in its virgin state. It has been learned, however, that man who continues to pollute his environment with his wastes eventually realizes a loss that he could have prevented but can correct only through the expenditure of considerable effort and monies.

Pollution in this basin while severe in some locations is not widespread. By abating existing excessive pollution the damaged water uses can be restored and by preventing additional pollution in the future these water uses will be preserved. The basin's water resources are vital to its continued prosperity, and expenditures made to preserve them will be returned to the people in many ways.

There are only three domestic water supplies using surface water sources but these serve almost 11 percent of the basin's entire population. It is important that the quality of these source waters be preserved by preventing further increased pollution. When existing pollution is abated, a savings will accrue to the consumers in the form of reduction in cost of treatment needed to produce a safe and palatable water.

The eight cities which have greater than 10,000 population and use well water sources for their domestic supply experienced an average population growth from 1940 to 1950 of over 17 percent. The increasing demand on these ground water sources may cause an increasing recession of the ground water table and consequently increasing pumpage costs. When the water demand increases sufficiently to make use of ground water impracticable or uneconomical, surface water sources will be sought. The shift from ground water to surface water sources by municipalities, which is taking place in many areas across the Nation, is likely to happen in this basin. Satisfactory pollution prevention practices will permit municipalities to shift to surface water sources at a lower cost to the water consumer, both in investment and operative costs, than would be possible if local streams remain polluted.

Availability of good quality water is a requisite to development of many industries and a major consideration in locating industrial plants. Particularly is this true of the food processing industries which are so prevalent in this basin. When other factors dictate location, then availability of water of the required quality is reflected in the cost of producing the industries' products. This is of importance to both the industry involved and the farmer, for the economy of the area depends in part on the ability to process the agricultural product close to the source.

Pollution abatement and preventive measures will restore waters lost to the stock farmers in certain areas and assist in assuring that this region continue as a leading producer of meat and meat products. This benefit is of great economic importance not only to the basin but also to the Nation as a whole.

In order to assure continued benefits of recreational use of the basin's waters, pollution control measures are necessary. Abatement of pollution will help in accomplishing wider development of these resources and prevention of future pollution will assure continued use. Wider development of the water resources for recreational use can mean shorter traveling distances from population centers to the fishing, bathing, and boating sites. This benefit is important to the lives of all the basin's people, particularly those who reside in urban areas.

POLLUTION PREVENTION MEASURES IN EFFECT

Eighty-three of the 93 municipalities in this basin with sewer systems provide treatment for their wastes. This treatment is provided for 93 percent of the contributory population.

TABLE C.--Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary.....	18[1]	19	26,740
Secondary.....	65[2]	65	292,525
No treatment.....	10	--	23,550

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers, industrial wastes discharged into municipal sewage systems.

[1] Includes one municipality which also has a secondary plant.

[2] Includes one municipality discharging to sewage treatment plant in another, one municipality with two sewage treatment plants, and one municipality which also has a primary plant.

Thirty-six existing municipal treatment plants, however, are reported to have inadequate capacity and do not give the degree of treatment which may ordinarily be expected from these plants. Forty-eight plants are considered to have satisfactory capacity and 60 of the existing plants are considered to be operated satisfactorily. A number of the plants now classified as having inadequate capacity are planning for improvements required to provide sufficient capacity to satisfactorily handle the loads expected. Among the larger municipalities where planning is being carried on to increase the capacity of existing plants are Cedar Rapids and Waterloo, Iowa, and Austin and Albert Lea, Minnesota.

Table D classifies the industrial sources of pollution according to the type of industry and shows the number of each type of industrial plants which provide treatment for their wastes. It will be seen that the predominant industry having separate outlets for discharging wastes directly to receiving waters is the food processing industry. The table shows that there is a total of 37 industrial plants discharging wastes and that 23 have provided treatment facilities, while 14 have not. Fourteen of the existing treatment plants have satisfactory capacity, but eight do not and the capacity of one is undetermined.

TABLE D.--Existing treatment facilities, industrial*

Type of industry	Number of plants	Number of treatment facilities	Industrial plants Having: No treatment facilities
Food and kindred products....	34	20	14
Paper and allied products....	1	1	0
Fabricated metal products....	2	2	0
TOTAL.....	37	23	14

*Industries having separate outlets and discharging wastes directly to watercourse.

The 48 sewage treatment plants with satisfactory capacity serve 102,785 people or about 30 percent of the sewered population. In all but three cases these plants are located in communities of less than 5,000 population and only one has an appreciable quantity of industrial waste in its sewage.

TABLE E.--Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal.....	84	48	36	0	60	22	2
Industrial.....	23	14	8	1	15	4	4

The 36 plants which are considered to be overloaded are serving a combined population of 216,000, or 63 percent of the sewered population, and are receiving a combined sewage and industrial waste which has, at times, a population equivalent of well over 1,000,000. These overloaded plants are doing a good treatment job, however, since they reduce the waste's strength to the extent that when discharged it has a combined population equivalent less than one-fourth of its original value. The three largest municipalities serve 40 percent of the basin's sewered population and are handling over 70 percent of the waste of the basin. They are doing an excellent job of treatment, as their plants remove 85 percent of the pollution load from the waste. The effluent from these plants, however, still represents half of the pollutional waste discharged to the basin's waters.

The large number of existing municipal waste treatment plants with unsatisfactory capacity is due to the fact that many have been used for long periods of time. The basin's first sewage treatment plant was placed in opera-

tion in 1913. Over one-fourth of the plants are over 30 years old and more than 60 percent are at least 20 years old. Six new sewage treatment plants and one industrial waste treatment plant have been constructed since 1947. The work that has been done and is being done to control pollution is encouraging, but there are certain points on the streams in this basin where additional pollutional control work is needed.

TABLE F.--Progress in pollution abatement

YEAR	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1947.....	2	650	0	--
1948.....	2	2,800	0	--
1949.....	1	900	0	--
1950.....	0	--	1	75,000
1951.....	1	800	0	--
1952.....	0	--	0	--

From the amount of construction that has been completed in the past years, it is evident that the State water pollution control agencies have been doing an excellent job; however, the activities of the agencies concerned have been somewhat hampered by lack of sufficient trained personnel and sufficient appropriations to properly expand their activities to meet the increased problems that confront them. It will be necessary to provide adequate appropriations if an efficient, well-operating pollution control organization is to be maintained to cope with the problem.

It is believed that in general the water pollution control laws of these three States are adequate to abate existing pollution and prevent or control new or increased sources of pollution. The water pollution control agencies have been given sufficient legal authority with which to carry on their programs and they have used this authority judiciously and effectively in carrying out their work. The following brief analysis presents the salient features of water pollution control legislation of the three States in this basin.

In Minnesota a comprehensive State water pollution control act was enacted in 1945 with authority vested in a Water Pollution Control Commission. The State Department of Health also has certain water pollution functions relating to public health and sources of water supply for domestic use. The Commission is given the power and duty to make such administrative classifications of the waters of the State as it may deem advisable and establish reasonable pollution standards of the waters of the State in relation to the public use to which they are or may be put. Also, the Commission has the power and duty to approve plans for disposal systems; to issue, continue in effect, or deny permits for the discharge of wastes or for the installation or operation of disposal systems

or parts thereof; and to revoke or modify any permit when necessary to prevent or abate pollution of any waters of the State. The Commission is authorized to hold hearings and issue orders, if necessary, to prevent pollution. Although the Commission is a separate and distinct entity, all investigations and other staff functions are performed by the Department of Health. There are no geographical or functional exemptions from the operations of the State water pollution control act.

In Iowa the water pollution control act vests the principal authority in the State Department of Health. The Iowa Natural Resources Council and the State Geologist also have certain functions relating to water pollution. The Iowa Natural Resources Council makes surveys of health and pollution problems relating to flood control. The State Geologist is responsible for protection of waters from pollution by oil or gas wells.

There is no specific statutory authority granted to the State Department of Health to develop a comprehensive program, to set standards of water purity, or to classify waters. However, the Department is authorized to exercise general supervision over public health, to promote public hygiene and sanitation, to investigate and prevent water pollution, and to make necessary rules. The Department is authorized to issue written permits, after approval of plans and specifications, for new sewerage or industrial waste systems as well as extensions or additions which would substantially increase water pollution. The Department may hold public hearings on water pollution and may order abatement of pollution. However, the order cannot be issued without the written approval of the majority of the members of the Iowa Natural Resources Council. Penalties are provided for violations of orders issued or unlawful pollution of State waters. There are no exemptions from the operation of the act since removal in 1949 of the restrictions under which the authority of the department did not apply to the border streams. The last amendments to the existing statutes of the State of Iowa considerably strengthen previous water pollution control legislation, under which a large measure of progress was made. Disposal of garbage and night soil into streams or on land subject to overflow is prohibited by an old statute not under direct administration or enforcement by the State Department of Health.

In Illinois control of water pollution is vested in the Sanitary Water Board under the Act of 1951, which superseded the Act of 1929. The Board has the authority to carry on comprehensive water pollution control programs, adopt rules and regulations, hold hearings, issue orders, and has authority to recover money sufficient for restoration of fish life which has been destroyed as a result of the violation of the act. The law also provides other penalties for violation of the act and enables the Board to control or prevent new or increased sources of pollution. The 1951 act includes provisions for requirement of certification of municipal sewage treatment plant operators as well as industrial waste treatment plant operators. The Sanitary Water Board Act does not apply to any existing sanitary district having a population of one million or more. There is some overlapping of jurisdiction between the Sanitary Water Board and the Conservation Department which protects fish and wildlife from pollution. Pollution originating from oil field wastes comes under jurisdiction of the Department of Mines and Minerals.

Formal orders to municipalities and industries for abatement of pollution have not been widely used as an administrative procedure in this basin. Instead, water pollution control agencies of the States have preferred to use a cooperative approach working closely with polluters in an attempt to secure abatement without exercising police powers. Generally formal orders have been used only in those cases where the cooperative approach has not been successful.

The water pollution control agencies of Illinois and Iowa (and Wisconsin) have jointly resolved, in a meeting held at Davenport, Iowa, on March 7, 1952, that, insofar as the Mississippi River is concerned, each does "agree to require the correction of existing and prevention of additional pollution within the boundaries of its State to the end that said waters may be maintained or rendered suitable for all purposes heretofore defined and that in the attaining of these objectives the guiding policy shall be the requirement that facilities for treatment of sewage and for industrial wastes shall provide at least effective sedimentation or equivalent, substantially complete removal of floating solids or liquids, and reduction of toxic materials to less than lethal limits for aquatic life, with the understanding that additional or special type treatment be required in those areas where water uses so dictate . . . ."

The States also have a policy of not issuing permits for construction of new sewer systems or extensions of existing ones unless the community requesting the permit has, or is actively planning to construct, adequate treatment facilities, where such action is authorized by their respective laws.

All of the watershed area in Iowa and Illinois and approximately 70 percent of the basin in Minnesota are now organized in Soil Conservation Districts. The Soil Conservation Service, working through these districts, provides technical assistance to the farmers in installing conservation practices such as contour farming, contour strip cropping, terracing, and improved rotations. All of these practices tend to reduce the sediment loads of the streams.

POLLUTION PREVENTION MEASURES REQUIRED

To obtain the maximum utilization of the waters in the Mississippi-Iowa-Cedar Rivers Basin, sewage and industrial wastes discharged to the streams must be treated to protect the receiving streams so that water of suitable quality is provided for the legitimate water uses. In view of the expanding industry in this area and the importance of agriculture to the economy of the region, the desired quality of the surface waters should be preserved for these uses in order to stimulate the greatest advancement of the economy of the whole basin. In addition, there is the moral obligation to protect the downstream water users' rights.

Water quality objectives which are pertinent to this basin have been discussed in that section of this report entitled "Uses of Water Resources." The type and design of each individual sewage treatment plant depend upon several variable factors that can be determined only after an engineering survey of local conditions and economics. The exact amount and/or type of wastes discharged are not known for several of the smaller problems in the basin, but in these cases preliminary studies and estimates are sufficient to set forth the need for a local engineering survey which in turn will result in the determination of the exact type of treatment needed. To insure that the treatment facilities will satisfy the requirements and to safeguard the taxpayer's investment, the State water pollution control agencies require the submission of plans for approval before construction is undertaken.

For much of this basin, the degree of treatment required is influenced by the amount of dilution water available during periods of critical low flow. In this region, two separate and distinct critical stream flow periods occur--the first during late summer and early fall and the second during midwinter. During low flow periods in hot weather, the water temperature rises and reduces the capacity of the stream to absorb and hold oxygen, and at the same time accelerates the rate of biological activity with a corresponding increase in the amount of oxygen required. During winter conditions of low flow, heavy and prolonged ice cover precludes or diminishes reaeration of the stream water, and biological activities, while progressing at a lesser rate than during periods of warm weather, must be wholly supported by oxygen contained in the receiving waters prior to the discharge of pollution. Where the quantity of discharge is large, as is the case in the principal communities where industry is concentrated, undesirable stream conditions are accentuated. It seems reasonable to expect that a high degree of treatment will be essential at those points where stream flows are critical in order to keep residual loadings within the stream's capacity for assimilation during low flow periods.

Preventive and corrective pollution control measures have been determined from results of stream surveys and other readily available data of the State agencies concerned. Construction of presently needed facilities and the adoption of waste prevention measures as soon as possible will restore, preserve, and protect existing legitimate water uses and those which may materialize in the immediate foreseeable future. Required control measures were determined only after a thorough consideration of all water uses and are considered to be reasonable and adequate. At the same time, it should be kept in mind that the corrective measures are intended to be flexible and reflect the needs of the

existing situation; however, changes in stream characteristics, pollutional load, or water uses may require that revisions be made in the indicated required treatment at some future date.

Considerable progress has been made in the Mississippi-Iowa-Cedar Rivers Basin in providing municipal and industrial waste treatment plants, but much additional plant construction, replacement, and expansion are needed before all waters of the basin will be adequately protected from the effects of municipal and industrial pollution. There is also a need for improved operation at a number of municipal and industrial waste treatment plants. Failure to operate waste treatment works at, or near, the peak of efficiency for which they were designed means that clean streams are not obtained as estimated and funds spent in anticipation of clean streams are largely wasted.

The presently available information shows that 10 new sewage treatment plants are needed to serve an estimated total of 23,500 persons. One of these new plants is needed to serve a city with a sewered population greater than 16,000, two are needed by communities with connected populations between 1,000 and 5,000, and 7 new plants are needed in communities with sewered populations under 1,000.

There are 20 existing sewage treatment plants that, because of age or gross overloading, can no longer efficiently produce a satisfactory effluent and should be replaced. These plants now serve a total sewered population of 27,630. In addition, there are 15 existing municipal waste treatment plants, now serving an estimated sewered population of 188,850, to which enlargements or additions should be made so that these facilities can do an adequate and proper job in controlling stream pollution. Three of the plants needing enlargement are treating sewage and industrial wastes which have a combined population equivalent of 930,000 people although they serve a total sewered population of only 133,000.

There are, in contrast to the above requirements, 48 existing municipal sewerage systems with a total connected population of 102,785 that are considered to be completely satisfactory for present conditions, and no additional treatment is required for these communities.

Using available cost data and making reasonable approximations of unknown cost factors, it is estimated that the cost of constructing the needed municipal facilities would total about $7,500,000 for this basin. An accurate estimate of the cost of construction of needed community waste treatment facilities is difficult since the cost of each project will depend upon local factors. The cost estimate given above covers treatment facilities only and does not include cost of land, right-of-way, collection sewers, etc., nor does it take into account maintenance and operating costs.

TABLE G.--Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	10	23,550	10
Enlargement or additions to existing plant	15	188,850	2
Replace existing plant	20	27,630	3
No project required	48[1]	102,785	17
Connect to municipal sewer	3	--	5

[1] Includes one municipality with two treatment plants, one satisfactory and the other needing additions, and one municipality served by another.

Of the 37 known industrial plants with separate waste outlets, 10 require new waste treatment plants (or outlets to municipal sewerage systems with treatment), two need to enlarge their existing plants, and three should replace their existing plants. With the exception of one metal fabricating plant which should replace its existing plant, all of the industries requiring new waste treatment plants or the enlargement or replacement of existing facilities are classified under the food and allied products listing. On the basis of admittedly incomplete information, it is estimated that the cost of industrial waste treatment facilities needed in this basin will total about one million dollars. This rough approximation is made with the realization that before an accurate estimate of the cost of needed facilities can be made additional information on the quality and quantity of the various wastes discharged must be known at certain plants in order to determine more accurately the degree and type of treatment required. It is also realized that certain in-plant changes in equipment, operation, and housekeeping may result in a decrease in the quantity and strength of waste discharged to watercourses and also may markedly decrease the total cost of treatment facilities required.

TABLE H.--Status of treatment works projects to abate pollution
July 1, 1953

Status of project	Number	
	Municipal	Industrial
Inactive	4	0
Plans under preparation	8	4
Final plans approved	7	0
Under construction	4	1
Status undetermined	22	15

Table H presents the currently available information of the status of projects to abate water pollution in this basin. It will be seen that four municipalities and one industry have their treatment facilities under construction and seven municipalities have final plans approved for construction. Eight municipalities and four industries are actively engaged in preparing plans for the needed treatment facilities.

Intensification of State water pollution control educational programs is important to long-range planning and good administration by water pollution control agencies. The undesirable effects of pollution on public health and water conservation must be presented to the public if its support of water pollution control measures is to be expected. Responsible officials, of both municipalities and industries, should be acquainted with expected treatment needs so that needed improvements can be planned for well ahead of the time when these needs become an actuality and damage to the stream has occurred.

TABLE 1.--Basic data on sources of municipal* pollution

Mississippi-Iowa-Cedar Rivers Basin

Name and location	Population served by sewers	P.E. (B.O.D.) untreated wastes**	Waste treatment provided	Adequacy of treatment facilities		P.E. (B.O.D.) discharged to watercourse	Treatment needs	Current status municipal* action
				Capy.	Opr.			
MISSISSIPPI RIVER:								
Muscatine, Iowa.....	16,000	--	None	--	--	Undet.	New Plant	Active planning
IOWA RIVER:								
Belmond, Iowa.....	1,900	1,900	Primary	Unsat.	Unsat.	1,500	Replacement	Active planning
Dows, Iowa.....	760	--	Primary	Unsat.	Unsat.	500	Replacement	Undetermined
Alden, Iowa.....	660	660	Secondary	Sat.	Sat.	100	None	
Iowa Falls, Iowa.....	3,300	--	Secondary	Sat.	Sat.	800	None	
Eldora, Iowa.....	2,000	--	Secondary	Sat.	Sat.	400	None	
Training School for Boys	790	--	Secondary	Sat.	Sat.	125	None	
Union, Iowa.....	380	400	Secondary	Unsat.	Unsat.	300	Replacement	Undetermined
Marshalltown, Iowa...	18,000	50,000	Secondary	Sat.	Sat.	500	None	
State Center, Iowa...	900	2,250	Secondary	Sat.	Sat.	250	None	
Garwin, Iowa.....	350	--	Secondary	Unsat.	Unsat.	150	Replacement	Undetermined
Toledo, Iowa.....	1,600	1,600	Secondary	Unsat.	Unsat.	1,200	Replacement	Active planning
Tama, Iowa.....	2,100	2,100	Secondary	Sat.	Sat.	300	None	
Dysart, Iowa.....	800	800	Secondary	Sat.	Sat.	150	None	
Belle Plaine, Iowa...	2,250	2,250	Secondary	Sat.	Sat.	400	None	
Marengo, Iowa.....	1,800	1,800	None	--	--	1,800	New plant	Final plans app.
Oakdale, Iowa T. B. Sanitarium...	475	--	Secondary	Sat.	Sat.	100	None	
Coralville, Iowa.....	Served by Iowa City sewage treatment plant							
Iowa City, Iowa.....	27,000	--	Secondary	Sat.	Sat.	3,000	None	
Williamsburg, Iowa...	1,100	1,300	Secondary	Unsat.	Sat.	500	Replacement	Under construction
Columbus Junction, Ia.	600	700	None	--	--	700	New plant	Inactive
Wapello, Iowa.....	1,300	1,300	None	--	--	1,300	New plant	Inactive

See footnotes at end of table.

TABLE 1.--Basic data on sources of municipal* pollution--Continued

Mississippi-Iowa-Cedar Rivers Basin

Name and location	Population served by sewers	P.E. (B.O.D.) untreated wastes**	Waste treatment provided	Adequacy of treatment facilities		P.E. (B.O.D.) Discharged to watercourse	Treatment needs	Current status municipal* action
				Capy.	Opr.			
EAST BR. IOWA RIVER:								
Garner, Iowa.....	1,500	--	Secondary	Sat.	Sat.	500	None	
Klemme, Iowa.....	350	--	Secondary	Sat.	Unsat.	70	None	
BEAR CREEK:								
Brooklyn, Iowa.....	1,100	1,900	Secondary	Sat.	Unsat.	600	None	
Victor, Iowa.....	700	700	Secondary	Sat.	Sat.	100	None	
ENGLISH RIVER:								
North English, Iowa..	700	1,500	Secondary	Sat.	Sat.	200	None	
Wellman, Iowa.....	800	1,500	Secondary	Sat.	Sat.	500	None	
Riverside, Iowa.....	500	500	None	--	--	500	New plant	Undetermined
CEDAR RIVER:								
Blooming Prairie,Minn.								
Plant A.....	500	--	Secondary	Sat.	Sat.	Undet.	None	
Plant B.....	500	--	Primary	Unsat.	Sat.	Undet.	Additions	Inactive
Austin, Minn.	18,000	80,000	Secondary (2 stage filtration)	Unsat.	Sat.	25,400	Enlargement	Active planning
St. Ansgar, Iowa.....	900	1,100	Secondary	Unsat.	Sat.	600	Enlargement	Undetermined
Osage, Iowa.....	2,500	6,000	Secondary	Unsat.	Sat.	3,000	Additions	Plans approved
Charles City, Iowa...	8,250	15,000	Secondary	Unsat.	Sat.	5,000	Additions	Undetermined
Nashua, Iowa.....	1,000	1,000	Secondary	Sat.	Sat.	150	None	
Plainfield, Iowa.....	250	--	Primary	Sat.	Sat.	Undet.	None	
Waverly, Iowa.....	4,000	--	Secondary	Unsat.	Sat.	1,000	Additions	Under construction
Denver, Iowa.....	500	--	Primary	Unsat.	Unsat.	375	Replacement	Undetermined
Janesville, Iowa.....	350	--	Secondary	Sat.	Unsat.	70	None	

See footnotes at end of table.

CEDAR RIVER--Continued								
Cedar Falls, Iowa								
Plant A.....	10,000		Secondary	Sat.	Sat.	Undet.	None	
Plant B.....	500		Secondary	Sat.	Sat.	Undet.	None	
Waterloo, Iowa.....	55,000	500,000	Secondary	Unsat.	Sat.	80,000	Enlargement	Active planning
Jesup, Iowa.....	900	2,000	Secondary	Sat.	Sat.	400	None	
Brandon, Iowa.....	150	150	Secondary	Sat.	Unsat.	50	None	
Vinton, Iowa.....	3,500		Primary	Sat.	Sat.	2,500	None	
Cedar Rapids, Iowa...	60,000	350,000	Secondary	Unsat.	Sat.	80,000	Enlargement	Active planning
Marion, Iowa.....	3,500		Secondary	Sat.	Sat.	400	None	
Mt. Vernon, Iowa.....	1,300		Secondary	Sat.	Sat.	400	None	
Lisbon, Iowa.....	720		Secondary	Sat.	Sat.	250	None	
Mechanicsville, Iowa.	800	800	Secondary	Sat.	Sat.	100	None	
Stanwood, Iowa.....	500	500	Secondary	Sat.	Sat.	100	None	
Tipton, Iowa.....	2,200	2,500	Secondary	Sat.	Sat.	400	None	
ROSE CREEK:								
Rose Creek, Minn.....	240	--	Primary	Sat.	Undet.	Undet.	None	
OTTER CREEK:								
Lyle, Minn.....	460	--	None	--	--	Undet.	New plant	Inactive
LITTLE CEDAR RIVER:								
Adams, Minn.....	610	--	None	--	--	Undet.	New plant	Undet.
Stacyville, Iowa.....	500	--	Secondary	Unsat.	Unsat.	500	Additions	Undet.
SHELL ROCK RIVER:								
Albert Lea, Minn.....	11,000	--	Primary	Unsat.	Unsat.	7,300	Replacement	Final plans app.
Northwood, Iowa.....	1,400	--	Primary	Unsat.	Unsat.	1,000	Replacement	Undet.
Manly, Iowa.....	1,100	1,100	Secondary	Sat.	Sat.	250	None	
Nora Springs, Iowa...	900	1,000	None	--	--	1,000	New plant	Undet.
Greene, Iowa.....								
West Plant.....	500	--	Primary	Unsat.	Sat.	350	Additions	Undet.
East Plant.....	500	--	Primary	Unsat.	Sat.	350	Additions	Undet.
Clarksville, Iowa....	850	850	Primary	Unsat.	Sat.	700	Replacement	Undet.
Shellrock, Iowa.....	800	800	None	--	--	800	New plant	Undet.

See footnotes at end of table.

TABLE 1.--Basic data on sources of municipal* pollution--Continued

Mississippi-Iowa-Cedar Rivers Basin

Name and location	Population served by sewers	P.E. (B.O.D.) untreated wastes**	Waste treatment provided	Adequacy of treatment facilities		P.E. (B.O.D.) Discharged to Watercourse	Treatment needs	Current status municipal* action
				Capy.	Opr.			
LIME CREEK:								
Emmons, Minn.....	300	--	Primary	Sat.	Undet.	Undet.	None	
Lake Mills, Iowa.....	1,500	--	Secondary	Sat.	Sat.	400	None	
Forest City, Iowa....	2,500	5,000 to 8,000	Secondary	Unsat.	Sat.	1,200 to 8,000	Additions	Undet.
Clear Lake, Iowa....	(6,000) (15,000S)	--	Secondary	Unsat.	Sat.	(1,500) (5,000S)	Enlargement	Contract awarded
Mason City, Iowa....	25,600	--	Secondary	Unsat.	Sat.	3,500	Enlargement	Undet.
WEST FORK CEDAR RIVER:								
Rockwell, Iowa.....	350	--	Secondary	Sat.	Sat.	Undet.	None	
Sheffield, Iowa.....	900	1,200	Primary	Unsat.	Sat.	1,000	Replacement	Final plans app.
Allison, Iowa.....	500	800	Secondary	Sat.	Sat.	100	None	
SPRING CREEK:								
Hampton, Iowa.....	3,500	5,800	Secondary	Unsat.	Sat.	600	Enlargement	Undet.
Dumont, Iowa.....	600	--	Secondary	Unsat.	Unsat.	150	Enlargement	Undet.
BEAVER CREEK:								
Ackley, Iowa.....	1,300	1,140	Secondary	Unsat.	Sat.	630	Replacement	Undet.
Aplington, Iowa.....	550	900	Secondary	Sat.	Unsat.	200	None	
Wellsburg, Iowa.....	600	800	Secondary	Sat.	Sat.	300	None	
Parkersburg, Iowa...	800	1,100	Secondary	Sat.	Sat.	300	None	
BLACK HAWK CREEK:								
Grundy Center, Iowa.	1,350	--	Primary	Unsat.	Unsat.	1,200	Replacement	Under construction
Reinbeck, Iowa.....	1,200	1,800	Primary	Unsat.	Unsat.	1,200	Replacement	Under construction
Hudson, Iowa.....	300	300	Primary	Unsat.	Unsat.	200	Replacement	Active planning

See footnotes at end of table.

WOLF CREEK:								
Conrad, Iowa.....	350	--	Secondary	Unsat.	Unsat.	200	Replacement	Undet.
Gladbrook, Iowa.....	580	600	None	--	--	600	New plant	Final plans app.
Traer, Iowa.....	1,500	2,000	Secondary	Sat.	Sat.	400	None	
LaPorte City, Iowa...	1,400	3,020	Secondary	Sat.	Sat.	240 to 900	None	
PRAIRIE CREEK:								
Keystone, Iowa.....	350	--	Secondary	Sat.	Sat.	50	None	
Van Horne, Iowa.....	400	400	Secondary	Sat.	Sat.	60	None	
Blairstown, Iowa.....	400	400	Primary	Unsat.	Sat.	300	Replacement	Undet.
MUD CREEK:								
Walcott, Iowa.....	390	390	Primary	Unsat.	Unsat.	390	Replacement	Undet.
Durant, Iowa.....	700	1,000	Secondary	Sat.	Unsat.	250	None	
Wilton, Iowa.....	1,000	1,600	Secondary	Unsat.	Sat.	1,200	Replacement	Active planning
WAPSI CREEK:								
West Branch, Iowa....	600	1,100	Secondary	Unsat.	Unsat.	500	Replacement	Final plans approved
West Liberty, Iowa...	1,400	2,200	Secondary	Sat.	Sat.	440	None	
SOUTH EDWARDS RIVER:								
Galva, Ill.....								
North Plant.....	1,500		Secondary	Sat.	Sat.	150	None	

(S = seasonal B.O.D. PE)

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers or other population centers.

**Includes industrial wastes discharged into municipal sewerage systems.

TABLE 2.--Basic data on sources of industrial* pollution

Mississippi--Iowa--Cedar Rivers Basin

Name and location	Type of industry	Type waste produced	Treatment or other pollution control measures			P.E. (B.O.D.) discharged to watercourse	Pollution abatement needs	Current status industrial* action
			Degree	Adequacy				
				Capy.	Opr.			
IOWA RIVER:								
Britt, Iowa								
Britt Rendering Plant.....	Food	Organic	None	--	--	Undet.	New plant	Undet.
Belmond, Iowa								
General Mills Soy Bean Plant.....	Food	Organic	None	--	--	3,800	New plant	Undet.
Alden, Iowa								
Alden Creamery.....	Food	Organic	None	--	--	200	New plant	Undet.
Marshalltown, Iowa								
Rendering Works.....	Food	Organic	Primary	Sat.	Sat.	Undet.	None	
Gilman, Iowa								
Gilman Cannery.....	Food	Organic	Irrigation	Unsat.	Unsat.	None	Enlargement	Undet.
Toledo, Iowa								
Toledo Coop. Canning Co.....	Food	Organic	Irrigation	Unsat.	Unsat.	Undet.	Enlargement	Undet.
Tama, Iowa								
Central Fibre Products Co.....	Paper	Organic	Minor	Undet.	Sat.	6,200	None	
Iowa City, Iowa								
Rendering Plant.....	Food	Organic	None	--	--	Undet.	None	
Williamsburg, Iowa								
Creamery.....	Food	Organic	None	--	--	150	None	To new municipal plant
York Coop. Cry. Assn.	Food	Organic	None	--	--	300	None	To new municipal plant
Columbus Junction, Iowa								
Cannery.....	Food	Organic	Primary (Lagoon)	Sat.	Sat.	None	None	
Morning Sun, Iowa								
Rendering Plant	Food	Organic	Secondary	Unsat.	Undet.	Undet.	Replacement	Undet.

See footnotes at end of table.

EAST BRANCH IOWA RIVER:								
Klemme, Iowa								
Klemme Coop. Creamery.....	Food	Organic	Primary	Sat.	Sat.	Undet.	None	
ENGLISH RIVER:								
Wellman, Iowa								
Maple Crest Turkey Plant.....	Food	Organic	None	--	--	1,000	New Plant	Undet.
CEDAR RIVER:								
Osage, Iowa								
Rendering Plant.....	Food	Organic	Primary	Unsat.	Undet.	Undet.	New Plant	Undet.
Waverly, Iowa								
Carnation Milk Plant	Food	Organic	None	--	--	2,000	Connect to city sewer	Under construction
Waverly Canning Fac.	Food	Organic	Irrigation	Sat.	Sat.	None	Connect to city sewer	Undet.
Cedar Falls, Iowa								
Clay Equipment Co...	Fab. metals	Inorganic	Primary	Sat.	Sat.	--	None	
Waterloo, Iowa								
Rendering Plant.....	Food	Organic	Primary	Unsat.	Undet.	Undet.	Connect to city sewer	Undet.
Garrison, Iowa								
Garrison Creamery...	Food	Organic	Irrigation	Sat.	Sat.	None	None	
Vinton, Iowa								
Minnesota Valley Can.	Food	Organic	Irrigation	Sat.	Sat.	None	None	
Center Point, Iowa								
Center Point Cannery	Food	Organic	None	--	--	Undet.	New Plant	Undet.
Cedar Rapids, Iowa								
Quaker Oats.....	Food & furfural	Organic	None	--	--	105,000	Connect to city sewer	Active planning
Penick & Ford.....	Food	Organic	None	--	--	48,000	Connect to city sewer	Active planning
SHELLROCK RIVER:								
Albert Lea, Minn.								
Wilson & Co.....	Food	Organic	None	--	--	38,000	New plant	Active planning

See footnotes at end of table.

TABLE 2.--Basic data on sources of industrial* pollution--Continued

Mississippi--Iowa--Cedar Rivers Basin

Name and location	Type of industry	Type waste produced	Treatment or other pollution control measures			P.E. (B.O.D.) discharged to watercourse	Pollution abatement needs	Current status industrial* action
			Degree	Adequacy				
				Capy.	Opr.			
SHELLROCK RIVER (Cont'd)								
Northwood, Iowa								
Creamery.....	Food	Organic	None	--	--	200	New plant	Undet.
Clarksville, Iowa								
Clarksville Cannery	Food	Organic	Primary (Lagoons)	Sat.	Sat.	None	None	
LIME CREEK								
Lake Mills, Iowa								
Cool Springs, Cannery.....	Food	Organic	Minor	Unsat.	Undet.	8,000	New plant	Undet.
Forest City, Iowa								
Forest City Canning Co.....	Food	Organic	Irriga-tion	Sat.	Sat.	None	None	
Mason City, Iowa								
Beet Sugar Plant...	Food	Organic & inorganic	Primary (Lagoon)	Sat.	Sat.	Undet.(1)	None	
Decker Meat Pkg. Co	Food	Organic	Secondary	Sat.	Sat.	3,000	None	
Rendering Plant....	Food	Organic	None	--	--	Undet.	New	Undet.
WEST FORK CEDAR RIVER:								
Hampton, Iowa								
Hampton Cannery....	Food	Organic	Irriga-tion	Sat.	Sat.	None	None	
BEAVER CREEK:								
Ackley, Iowa								
Marshall Canning...	Food	Organic	Irriga-tion	Sat.	Sat.	None	None	

See footnotes at end of table.

BLACK HAWK CREEK:								
Grundy Center, Iowa								
Canning Factory....	Food	Organic	Primary (Lagoons)	Unsat.	Unsat.	Undet.	Replacement	Undet.
Reinbeck, Iowa								
Reinbeck Cannery...	Food	Organic	Irrigation	Sat.	Sat.	None	None	
Hudson, Iowa								
Hudson Creamery....	Food	Organic	None	--	--	2,700	New plant	Undet.
Waterloo, Iowa								
John Deere Plant...	Fab. metals	Organic & inorganic	Primary (Lagoons)	Unsat.	Unsat.	Undet.	Replacement	Active planning

[1] Discharged during flood flows.

*Industries having separate outlets and discharging wastes directly to watercourse.

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